ON SCENE

THE NATIONAL MARITIME SAR REVIEW

DEPARTMENT OF TRANSPORTATION

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SAR SATELLITE PROJECT

United States agencies are planning to conduct an extended SAR Satellite demonstration project to begin in the early part of 1981. The orbiting satellites will monitor existing Emergency Locator Transmitters (ELTs) and Emergency Position Indicating Radio Beacons (EPIRBs). A developmental emergency beacon, especially configured for the space age, will form an experimental package within the project. The system will provide for alerting by means of listening via satellite and for locating by means of satellite doppler techniques.

Many aircraft flying in United States airspace are required to carry ELTs (these are analogous to Survival Radio Equipment and Emergency Location Beacons - Aircraft (ELBA) required in some cases by Annexes to the Convention on International Civil Aviation) and some U. S. merchant ships are required to carry EPIRBs. Both of these equipments transmit on 121.5 MHz and 243.0 MHz. In addition, quite a number of seagoing yachts have voluntarily fitted out with EPIRBs of this type.

ENDORSEMENT BY THE INTERAGENCY COMMITTEE ON SAR

A year-long study by a special working group of the Interagency Committee on Search and Rescue (ICSAR) resulted in an endorsement by the committee of the concept. This study and another made separately by the Coast Guard fundamentally agreed that a shared polar orbiting satellite system would be the best method of providing an alerting feature for the existing ELT/EPIRB. Similar conclusions were arrived at independently by Canadian authorities. This interest by Canada in the concept and interest shown by other nations may lead to the project becoming an international one.

SYSTEM OBJECTIVE

The immediate objective of the system will be to detect and locate ELT/EPIRBs transmitting on the North American continent and in related maritime areas. It is believed that the system holds great promise for reducing the time between the occurrence and the detection of a distress incident, and for providing a distress incident position within 10-20 km for existing ELT/EPIRBs and to less than 5 km for the developmental type.

SYSTEM DESCRIPTION

The signal acquisition and processing techniques will take account of the problems associated with existing devices--- low signal strength, poor frequency stability, and a variety of modulation tech-

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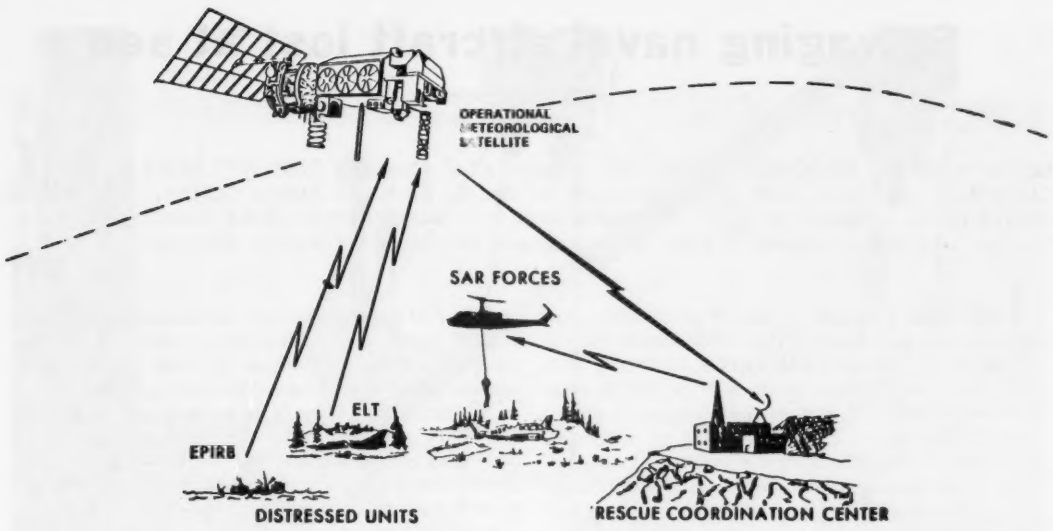


FIGURE 1. SEARCH AND RESCUE SATELLITE SYSTEM CONCEPT

niques. The system will use a near polar, 700-1000 km orbit. In addition to the 121.5/243.0 MHz capability, the satellites will carry a more advanced system which will operate with developmental emergency transmitters in the 406 - 406.1 MHz band. The new devices will access the satellite via a coded address and will provide an identification of the transmitter as well as the capability for situation coding.

The existing ELT/EPIRBs will transmit their signals to the orbiting satellite. The satellite will relay the signals to and earth station which will process the doppler information to determine the position. The ground station will relay the processed data immediately to the appropriate rescue coordination center for action. Figure 1 shows the concept with the ground station co-located with the rescue coordination center.

Signal processing of the developmental ELT/EPIRB will be done on board the satellite. This will allow for data storage in the satellite with readout by command from a ground station. In either a real-time or stored mode, the data will be used to compute the position of the distress, identify the unit transmitting and display the situation (e. g. ship on fire, sinking, or medical emergency).

METEOROLOGICAL SATELLITES TO BE USED

The system can operate with one to five satellites. There is a 12 hour maximum waiting time with one satellite and a 2 hour maximum waiting time with five. The space component of the distress-alerting system will be placed into meteorological satellites which are already scheduled for launching. It is expected that a four satellite system will be in operation by the completion of the demonstration phase.

SYSTEM OPERATION

The system will process the data so that within 5 minutes after the signal is first detected by the ground terminal (including 4 minutes of doppler tracking), the location data will be displayed at the ground terminal control console. Signal processing for the current ELT/EPIRBs will be accomplished at small ground terminals located at or near rescue coordination centers. Since the system will use polar orbiting satellites, any area of the world can be covered if ground terminals are available in the desired area. With the existing ELT/EPIRBs the satellite must be in view of both the ELT/EPIRB which is transmitting and the ground terminal. With the developmental ELT/EPIRB, this will not be necessary because of the processing and storage capability of the satellite.

Salvaging naval aircraft lost at sea

By Richard P. Shipman
Naval Safety Center

Editor's Note: *The following article is reprinted from the July 1977 issue of "APPROACH" magazine, with the permission of the U. S. Naval Safety Center. The article should be of interest to all Coast Guardsmen, --- particularly those attached to Buoy Tenders and other vessels likely to be engaged in salvaging sunken aircraft.*

FOR almost 2 months, the team of salvage experts had been attempting to recover an elusive F-14 *Tomcat* that had plunged from the deck of USS JOHN F. KENNEDY. With the supersecret Phoenix missile and its AWG/9 radar control system aboard, vital military information could fall into foreign hands if the wreckage was left unsalvaged. Furthermore, the AMB (accident mishap board) wanted to recover the wreckage to establish the cause of the runaway engine that had propelled the F-14 off the deck. The F-14 *had* to be recovered!

The search effort had been hampered from the first by the elements. The *Tomcat* went down in relatively deep water (1900 feet) in an area of the North Atlantic known for its high winds and heavy seas. Often encountering 35- to 45-knot winds and seas in excess of 12 feet, navigational, search, and recovery efforts had been severely complicated. In addition to the elements, equipment failures plagued the crew.

Eventually, the *Tomcat* was located, but recovery proved even more difficult than detection. Lines attached to the aircraft broke under the strain of the heaving ship. A specially fabricated steel net designed to snare the F-14 proved too weak to hold it. Aircraft attachment points broke loose from the repeated stress placed upon them by the efforts to raise the aircraft. Twice the fighter was raised near the surface; twice it broke free and returned to the ocean floor.

Finally, almost 2 months after the crash, salvage crews were able to snag the aircraft using span wire towed between two ships. With the *Tomcat* snagged and in tow, the ships proceeded to shallow water where the sea finally and reluctantly relinquished the *Tomcat.*

This remarkable recovery is indicative of what can be done in underwater salvage of downed aircraft. And, increasingly, the Navy has been attempting to recover aircraft lost at sea. Obviously, recovery of aircraft wreckage is imperative to any accident investigation if any doubt exists as to the cause of the accident. Consider the following accidents that would have remained mysteries forever had the wreckage not been salvaged:

Underwater visibility is an important factor in recovery operations. Conditions can range from excellent, as in this photo, to as limited as 1 to 2 feet.

- An F-4J pitched up violently and unexpectedly during an ACM engagement. It subsequently departed controlled flight and crashed off the coast of North Carolina. An intensive salvage effort produced the wreckage, specifically, the tail section. As a result of the wreckage investigation, a discrepancy was found in the horizontal stabilizer (stabilator) that had caused the aircraft to go out of control. Thus a serious problem that had only been suspected in previous accidents was confirmed and corrected.

- An RA-5C crashed off the coast of Florida during a routine training flight at 13,000 feet. Following an electrical failure, both crewmen ejected in level flight. Recovery of the wreckage revealed an inflight fire in the bomb bay area.

- An F-4 experienced a firewarning light on the port engine. The pilot shut the engine down and headed for a nearby airfield. Enroute, the controls seized and the crew ejected. Extensive effort by divers and salvage personnel recovered the port engine and identified the cause – a leaking fuel nozzle. It had sprayed jet fuel into the engine bay, starting a fire that burned through hydraulic lines, control linkages, and eventually caused the crash. Another "undetermined" accident was solved, resulting in action to prevent similar mishaps.

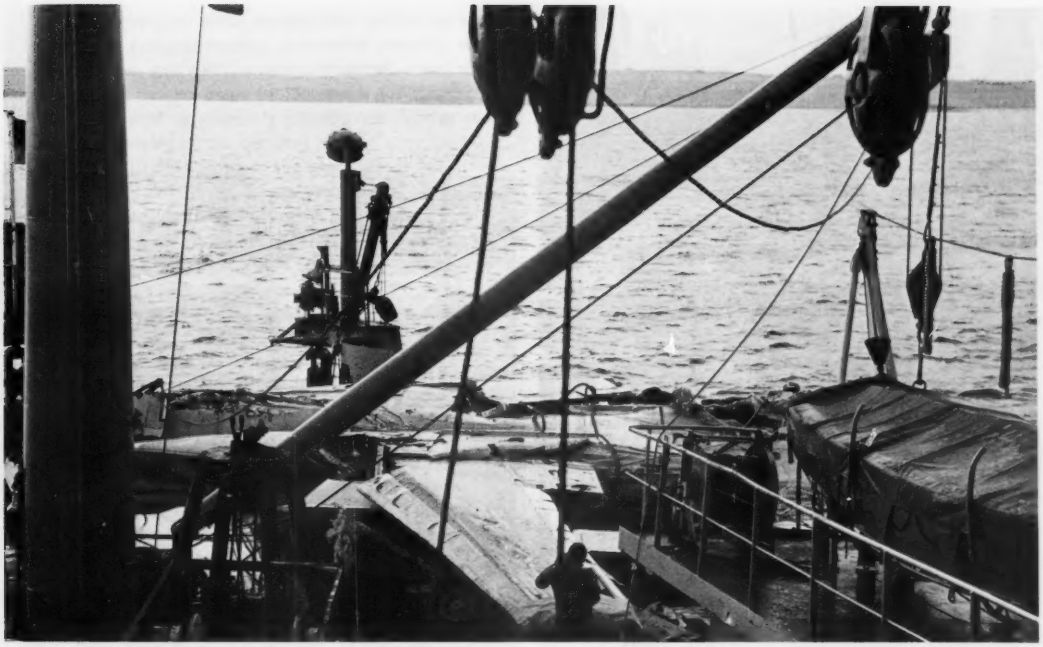
These are but a few examples of the value of recovering aircraft lost at sea. Clearly, underwater salvage is an important aspect of aircraft accident investigation today and will continue to be in the future.

So, what is involved in a salvage operation? What is the squadron's role in the process, and what can the squadron do to make a more effective salvage? This article will attempt to answer these questions by giving an overview of salvage operations.

The salvage process is not easy. Nor is it cheap. But the state of the art today is such that the Navy can recover aircraft lost in thousands of feet of water, if the importance of the operation demands it.

That's the key word – importance. Obviously, it would be ideal to salvage every aircraft that crashed at sea, but that's not financially realistic. Therefore, the first step in any underwater recovery effort is to decide if the value of the wreckage is worth the recovery cost. This judgment is based on several factors:

Continued



The recovery of an F-14 *Tomcat* from 1900 feet of water during adverse weather conditions demonstrates the salvage capability that exists today.

- The importance of finding a cause. Accidents which appear to have widespread implications have higher priority than suspected isolated problems.
- Extent of information available. If the mishap board can obtain statements from surviving crewmembers and/or witnesses, the wreckage may not be necessary to identify a probable or definite cause. Salvage in this situation would be redundant and unnecessary. The less information available, the more important the salvage.
- Type of aircraft involved. It would be more important for the Navy to find and fix material failures in an F-14 or S-3 than in the familiar T-28. New aircraft typically have problems that need ironing out, so identification of these problems early in the aircraft's development is critical.
- Accessibility of the wreckage. Although the capability exists to recover aircraft lost in deep water, the deeper the water, the more difficult and expensive the salvage.

In reality, the decision to salvage is made by several commands. If the squadron decides it wants to salvage an aircraft, it passes this request, along with the justification, to the appropriate type commander (controlling custodian). The TYCOM and the Naval Safety Center then decide on the potential gain from salvage, and if considered warranted, a request for salvage assistance is sent by message to the Commander, Naval Sea Systems Command, Supervisor of Salvage branch. These procedures are contained in OPNAVINST 3750.6K, para 405(c).

The SupSalv (Supervisor of Salvage) possesses the expertise for the salvage effort. He has available to him Navy submarine rescue and other diving ships (ATF, ASR, ARS), harbor clearance units, Navy divers and swimmers, as well as specialized civilian contractors. An expert from SupSalv will be assigned to each salvage effort. He will coordinate what assets are needed and be in charge of the recovery effort.

The SupSalv coordinator will start the typical recovery effort by meeting with members of the accident board to get as much information as possible before start of operations. Things he will want to know include:

- Unique aircraft characteristics (attachment points for lifting lines, special hazards, etc.).
- Course, speed, and angle of impact.
- Time of crash.
- Source of fixes, and type of fixes used to mark wreckage.
- Hazardous stores/cargo, status of ejection seat.

The F-14 is hauled aboard the commercial ship TAURUS. The hoisting phase of wreckage recovery can be very difficult due to the weight of waterlogged airframes.

USS SHAKORI (ATF 162), a fleet ocean tug, is one type of ship used commonly in salvage operations.

- Weather conditions at time of crash and subsequent.
- Water depth, type currents.

Once this and all other pertinent background information has been analyzed, the operation begins. The salvage of wreckage can usually be divided into two separate operations: search and location of wreckage and recovery of wreckage.

To the uninitiated, location of the wreckage may not appear to be a big problem. But it is! A precise fix is usually not available to mark the exact location where the aircraft entered the water. Even if a good fix can be obtained, water acts on an airfoil just like air, and an aircraft is likely to "sail" some distance from where it went in. Add to this underwater currents and vastness of the oceans, and location is indeed a problem.

Several search systems are available, among them hull-mounted sonars, submarines, television systems, and swimmers/divers. The most effective and widely used search system is the side-scanning towed sonar unit. Development of this piece of equipment has been one of the primary reasons for the increasing success of salvage operations.

The side-scanning sonar is a cylindrical "fish" which is attached to a tow line from a towing vessel. The sonar is usually towed close to the bottom and sends out short, acoustic, fan-shaped pulses that bounce off objects. The information is relayed to recorders onboard the towing ship, and a graphic portrayal of the outlined article is presented.

The main limitations of the towed sonar are water depth and bottom topography. Presently, towed sonars are limited by the length of cable that can be attached, effectively restricting operations to water depths no greater than 6000 feet. Bottom topography that is extremely rough will hinder use of the sonar due to the many returns that make identifying a single target very difficult. While substitute search methods are available, they are either much more expensive or considerably less effective. Hull-mounted sonar is not precise enough to define aircraft debris. Submarines and more exotic salvage vehicles such as the Alcoa *Seaprobe* are extremely expensive. Television and swimmers/divers are very limited in the range they can search. Thus, towed sonar is the mainstay of search efforts. Fortunately, sonar can be used in most salvage efforts.

Once an object has been outlined by the towed sonar, positive visual identification is usually required to ensure that it is the desired wreckage. To accomplish this, TV

cameras, divers, or more sophisticated vehicles such as the CURV III (cable-controlled underwater recovery vehicle), Deep Drone, and NR-1, a nuclear-powered, ocean research submarine, can be used. In the search for the F-14, the NR-1 was used to positively identify the *Tomcat* once it had been located by the side-scan sonar.

Critical to the success of the sonar search is a precision navigation system. Since the sonar can cover only a limited width at any one time (usually 150 meters on either side), it is necessary to go back and forth over the search area in the manner of mowing a lawn. Since no freshly cut grass exists to mark the area already searched, a precision navigation system must be used to keep track of the search lanes. Also, the precision navigation unit is needed to fix the wreckage location exactly, once it has been located. This frees the search ship to return to Homebase and prepare for the recovery phase of the operation.

Once the wreckage has been located, identified, and marked, the recovery phase begins. Here again, the salvage coordinator has a variety of vehicles to use depending on the nature of the recovery. Factors to be considered include:

- Overall object size, weight, construction, and condition of wreckage.
- Final distance offshore.
- Average weather and sea state.
- Water temperature.
- Type bottom and depth of water.

The variety of equipment that can be used is illustrated by the following actual recoveries: An F-4J was recovered from Subic Bay by USS GRASP, an ARS (salvage ship). An Air Force F-106 was recovered with a YSD, a self-propelled floating crane; and the F-14 recovery used an ATF (Fleet tug) in addition to several commercial salvage vessels of other nations. Other common assets available to SupSalv include ASR (submarine rescue ships) and ATS (salvage towing ships).

Typical recovery operations involve sending swimmers/divers down to the wreckage to attach nets or lines to the debris. Nets are used if the wreckage is scattered and small, while lines are used for large intact parts. Heavy-duty winches and cranes then haul the parts to the surface for analysis.

Perhaps it is easier to visualize the overall salvage procedure by reviewing an actual operation. On 6 August 1976, an F-4N attached to VF-101 Det Key West crashed in the Gulf of Mexico, northwest of Key West. The fighter had been engaged in one-on-one tactics. Following the third engagement, the RIO of the accident aircraft broadcast

The CURV (cable-controlled underwater recovery vehicle) can be used to verify wreckage located by the side-scan sonar.

"knock it off," and the lead aircraft acknowledged while rolling into an easy turn to expedite the rendezvous for return to base. Instead of joining, however, the wingman began a descent from approximately 10,000 feet. As his speed increased and his nose attitude steepened, the lead called "watch your altitude!" The aircraft failed to pull out. The RIO initiated ejection just prior to water impact, but neither crewmember survived the accident.

With no survivors and virtually no information to shed light on the accident cause, recovery of the wreckage was imperative. Since the aircraft was not out of control, it was conceivable that some aircraft malfunction existed that prevented the crew from recovering. A problem of this nature would have major ramifications for the entire *Phantom* community, both Navy and Air Force. The aircraft had to be recovered.

The lead aircraft had marked a TACAN fix where he observed the aircraft to go in, and Navy and Coast Guard ships positioned a moored barrel near floating debris. The depth of water in the area was approximately 100 feet. Local EOD (Explosive Ordnance Disposal) divers initiated a search, but almost immediately terminated due to large sharks in the search vicinity.

When the AMB determined that salvage was beyond the capability of the squadron, the senior member of the board contacted NAVAIRLANT and the Naval Safety Center for assistance. The board stressed the importance of the recovery; AIRLANT and NAVSAFECEN concurred. The decision was made to go ahead. On Friday, 13 August, a message was sent to the Supervisor of Salvage requesting salvage assistance.

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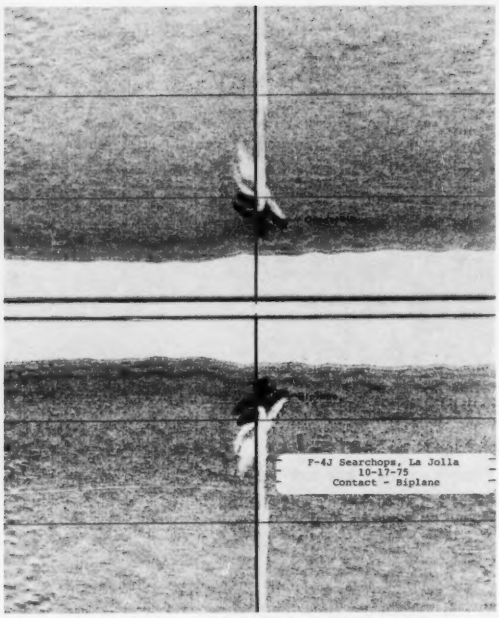


Example of side-scan sonar trace. An old WWI biplane was traced during search for an F-4J.

SupSalv assigned LCDR W. J. Tageson, USN, as the salvage representative for the operation. Simultaneously, Seaward, Inc., a civilian firm and the prime Navy contractor for search and recovery tasks, was alerted to furnish a search team. Seaward's representative on the accident was Bob Kutzleb, Vice President/Operations. He is one of the acknowledged experts in the underwater recoveries and has participated in many operations, including the remarkable F-14 recovery. Kutzleb and his firm were responsible in this operation for setting up the navigation system and providing the sonar unit.

LCDR Tageson, Bob Kutzleb, and VF-101 personnel met on 17 August to conduct a preoperation brief. Positioning data, accident background information, witness statements, and equipment arrangements were thoroughly discussed. The recovery team purchased nautical charts of the search area and commenced plotting fix points.

While the search and recovery team was involved in its briefing, the USS ESCAPE (ARS 6) had been selected as the search and recovery platform for the recovery and was en route from Mayport, FL. It arrived 19 August, and the sonar team and navigation equipment were loaded aboard.

With the navigation equipment calibrated and the sonar unit checked out, ESCAPE got underway on Saturday, 21 August. By 2000, the ship was in the crash vicinity, and the sonar "fish" was launched to commence the search pattern. A small contact appeared shortly thereafter, and while it appeared too small to be the aircraft, the team decided to investigate further in the event this contact might be a portion of the wreckage.

Divers were put over the side to search out the contacts. They located scattered wreckage of an old shrimp trawler – but no aircraft. The dive boat was recovered, and the search pattern continued.

After searching continually for the next 2 days, a good contact appeared at 0500 Tuesday morning. Divers again went over the side to verify the finding. They confirmed that it was the F-4N – engines, cockpit, and other debris.

The recovery ship established a two-point moor over the wreckage, and recovery operations began. The divers were able to use SCUBA equipment due to the shallow water (less than 100 feet). Had the water been deeper, the divers would have been forced to go to an air or helium/air breathing rig, requiring hardhat dives. The reduced mobility and decompression requirements of the hardhat dives necessarily slow a recovery effort.

Raising the parts presented no particular problems, and by 27 August, nearly all significant aircraft components had been recovered. The search crew disbanded.

As a result of this successful salvage, the aircraft mishap board was able to determine:

- The aircraft was in balanced flight when it crashed, approximately 65 degrees nose low, 230 degrees right roll, airspeed in excess of 500 KIAS.
- No airframe structural failures occurred prior to impact.
- Primary electrical power was available until impact.
- Both engines were operating at MRT prior to impact.
- Stabilator control cylinders revealed that the pilot had made no conscious effort to recover from the dive.
- No ejection was attempted by the pilot.

Based on this information, the board concluded that pilot incapacitation was the probable cause of the accident. No further action was necessary in the F-4 community, as no aircraft problems were discovered.

While this was one example of a salvage operation, it is not necessarily typical. Indeed, experts in the field will tell you there is no such thing as a typical salvage effort. Each one seems to present new and different problems and circumstances. Nevertheless, there are certain things that squadrons can do in every accident at sea where a salvage effort may be contemplated.

Perhaps the most important thing is to get as accurate a fix as possible to mark the crash location. TACAN fixes are the first and most obvious method. While these are better

SCUBA divers can be used to identify wreckage and attach hoisting cables if water depth is less than 100 feet.

Civilian contract ships are sometimes used in salvage operations that require special equipment. German sailors from M.V. TAURUS play out hoisting cable in an attempt to raise the F-14.

than nothing, they do have limitations. When slant range distortion, aircraft movement, and equipment accuracy are considered, TACAN does not really provide the degree of accuracy desirable to pinpoint wreckage.

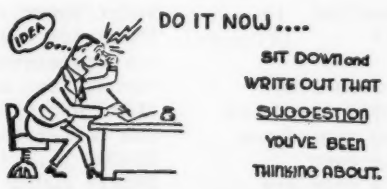
So, try to back up and supplement any TACAN fixes with other techniques such as marker buoys, ship navigation fixes (LORAN, SINS), inertial plots from aircraft so equipped, and any other methods possible.

The best solution to the location problem would be to have all naval aircraft equipped with acoustic pingers. Formally called acoustic locators, the pinger is a small beacon transmitter about 4 inches long which weighs about 9 ounces. It is attached to the aircraft structural frame and is designed to survive severe crash conditions and commence operating upon water entry. The pinger sends out a signal which can be used to home in on. These pingers are currently installed in test and evaluation aircraft and are being installed in CONUS-based F-14 and A-7E aircraft. CNO has authorized installation in other service aircraft, and this will be implemented in the future as funds become available and the engineering changes are prepared and promulgated. For more information on the pingers, see MAY '75 APPROACH ("Unlocking Davy Jones' Locker").

While marking the wreckage is probably the most important thing the squadron can do, there are other functions for members of the AMB to perform in a salvage effort. Search and recovery teams rely on the squadron's expertise to gain information they need about the aircraft. Be ready to give them such information as aircraft weight, strong points for lifting, hazardous areas, and similar matters. You may be asked to provide a standard lifting harness if the aircraft is relatively intact and upright.

It's also important that a member of the mishap board be onboard during the wreckage search and recovery. His expertise will be needed for identification of the aircraft parts and other onsite advice. He also should view the wreckage as soon as possible when it is onboard, and if feasible, make arrangements for a freshwater washdown of the recovered parts. One word of caution. If you sometimes think flying is "hours and hours of sheer boredom," wait until you experience a sonar search effort when the wreckage location is not too well pinpointed!

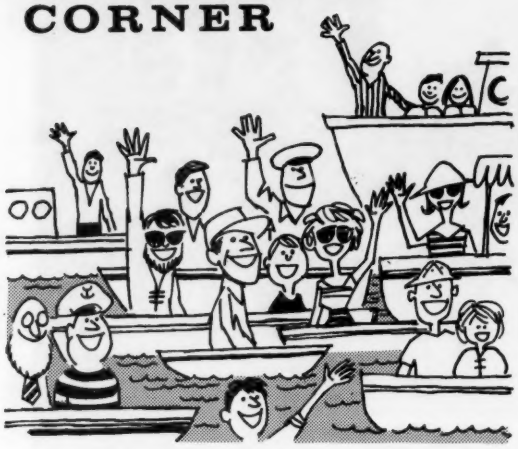
Laborious or not, the salvage of naval aircraft will continue to assume increased importance in the future. As aircraft become more expensive and scarce, it becomes even more important that every crash be fully investigated and a cause revealed so that future accidents can be prevented. The future of the Navy's readiness and the safety of naval aircrews demand it. ◄



DO IT NOW....

SIT DOWN and WRITE OUT THAT SUGGESTION YOU'VE BEEN THINKING ABOUT.

KUDOS CORNER



To: Commandant

I would like to call your attention to a dramatic incident as well as expressing my thanks and appreciation to you and the men of the United States Coast Guard on behalf of the crew, captain, and guests aboard the LADY MARGARET .... the LADY MARGARET was a vessel of character, history, and great tradition .... Unfortunately, on its passage to Florida the vessel foundered and sank near Cape Fear. Only because of the courage and dedication of the members of the United States Coast Guard were we able to be thankful for the lives of eight of the nine persons aboard the LADY. We shall all be eternally grateful to those unknown men who risked their lives to save the lives of others. I would be most appreciative if you would extend our sincere thanks for their unselfish dedication. /s/ John P. McGoff, President, Global Communications Corp.

FM: American Embassy, Nassau, Bahamas
To: Commander, Seventh Coast Guard District (and others)

Subj: SAR Operations S/V PHANTOME, 19, 20 and 21 January 1977

The response and assistance from CCGD SEVEN, USCGC STEADFAST and USCG Air Units was outstanding. The shining reputation of the USCG in the Bahamas is even brighter and 139 people and a ship are safe to sail again, thanks to the efforts of the USCG, Bahamas Air Sea Rescue Association and USS PETREL. Please extend my personal appreciation and congratulations to all USCG members who participated in this magnificant effort .... Well done. /s/ Ambassador Olson

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To: Commandant

.... Coast Guard helicopters from Elizabeth City evacuated 17 crew members from the Corps of Engineers Nuclear Power Barge STURGIS .... on 7 January .... the performance and professional competence of the rescue helos was in all respects truly outstanding. The evacuation of the 17 men and 5 dogs in some 21 minutes in very high seas went off like clockwork .. .. The following day the cutter POINT MARTIN relieved the USS DEWEY as escort in the vicinity of Frying Pan Shoals .... Would you be so kind as to relay my thanks, appreciation and admiration to the crews of the aircraft ... and to the crew of the POINT MARTIN ..... /s/ Warren D. Dietrickson, Zapata Marine Service, Inc.

To: Commandant

I am writing to express my appreciation for the assistance rendered to the yachts BREEZE ALONG and AZURE DRAGON .... While returning from the Fort Lauderdale to Key West race, the AZURE DRAGON had engine failure. .... we elected to remain outside .... and maintain visual contact with .... the AZURE DRAGON as she sailed during the night. The Islamarada Coast Guard kept in touch with us all night and kept the other Coast Guard Stations informed as to our position as we moved up the coast. AZURE DRAGON was forced further and further out to sea .... BREEZE ALONG blew two sails and maintained visual contact .... only under power .... We ran low on fuel .... The Coast Guard Cutter CG 41341 came to our assistance promptly and very efficiently and skillfully refueled BREEZE ALONG under the most adverse conditions. The cutter than towed the disabled AZURE DRAGON .... /s/ Hans Trenker, Skipper, BREEZE ALONG

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